

SHORT COMMUNICATION

***Hydrocotyle eichleri*, *H. papilionella* and *H. tuberculata* (Araliaceae),
three new annual species from Western Australia**

Three new species of *Hydrocotyle* L. from the south-west of Western Australia are described and illustrated herein. All three species were previously given manuscript names by Hansjörg Eichler in the 1970s and 1980s but were never published. They differ from most members of the genus in being annuals with ebracteate umbellate inflorescences and ornately papillate fruits with conspicuously raised and incurved lateral ribs, distinctly concave ‘pits’ between the lateral and median ribs and a persistent subulate carpophore. They share most of these characters with the widespread Australian species *H. callicarpa* Bunge but that species lacks papillae on its fruits (Figure 1). A key is provided to these four species. All of the new species currently have conservation priority.

Key to Western Australian species of *Hydrocotyle* allied to *H. callicarpa*

1. Schizocarps broadest at the centre, unwinged, with a cordate base
2. Mericarps lacking papillae ***H. callicarpa***
- 2: Mericarps with two or more papillae
3. Many papillae between the dorsal, lateral and median ribs ***H. tuberculata***
- 3: Two (rarely three) papillae in a pit between the lateral and median ribs ***H. eichleri***
- 1: Schizocarps broadest towards the summit, where there are projecting wings,
with a truncate base ***H. papilionella***

Hydrocotyle eichleri* A.J.Perkins, *sp. nov.

Type: inland lake west-north-west of Esperance, Western Australia [precise location withheld for conservation reasons], 14 September 1998, *M.N. Lyons & S.D. Lyons* 4890 (*holo*: PERTH 08933529; *iso*: MEL).

Hydrocotyle crassipes H.Eichler ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Hydrocotyle sp. *Crassipes* (K.R. Newbey 7567), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 1–5 cm high and 1–6 cm wide. *Stems* ascending, yellowish green to pale crimson, terete, glabrous. *Stipules* white to cream, oblanceolate to linear lanceolate, 0.8–2.0 mm long, 0.8–1.2 mm wide, membranous, translucent, entire to irregularly toothed along margins. *Petioles* yellowish green to pale crimson, 1.5–7.5 mm long, glabrous. *Leaf blades* simple, dorsiventral, carnosely, trilobed to palmatifid, 2.0–6.0 mm long, 2.0–7.5 mm wide; adaxial surface green to yellowish green to pale crimson, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous. *Leaf margins*

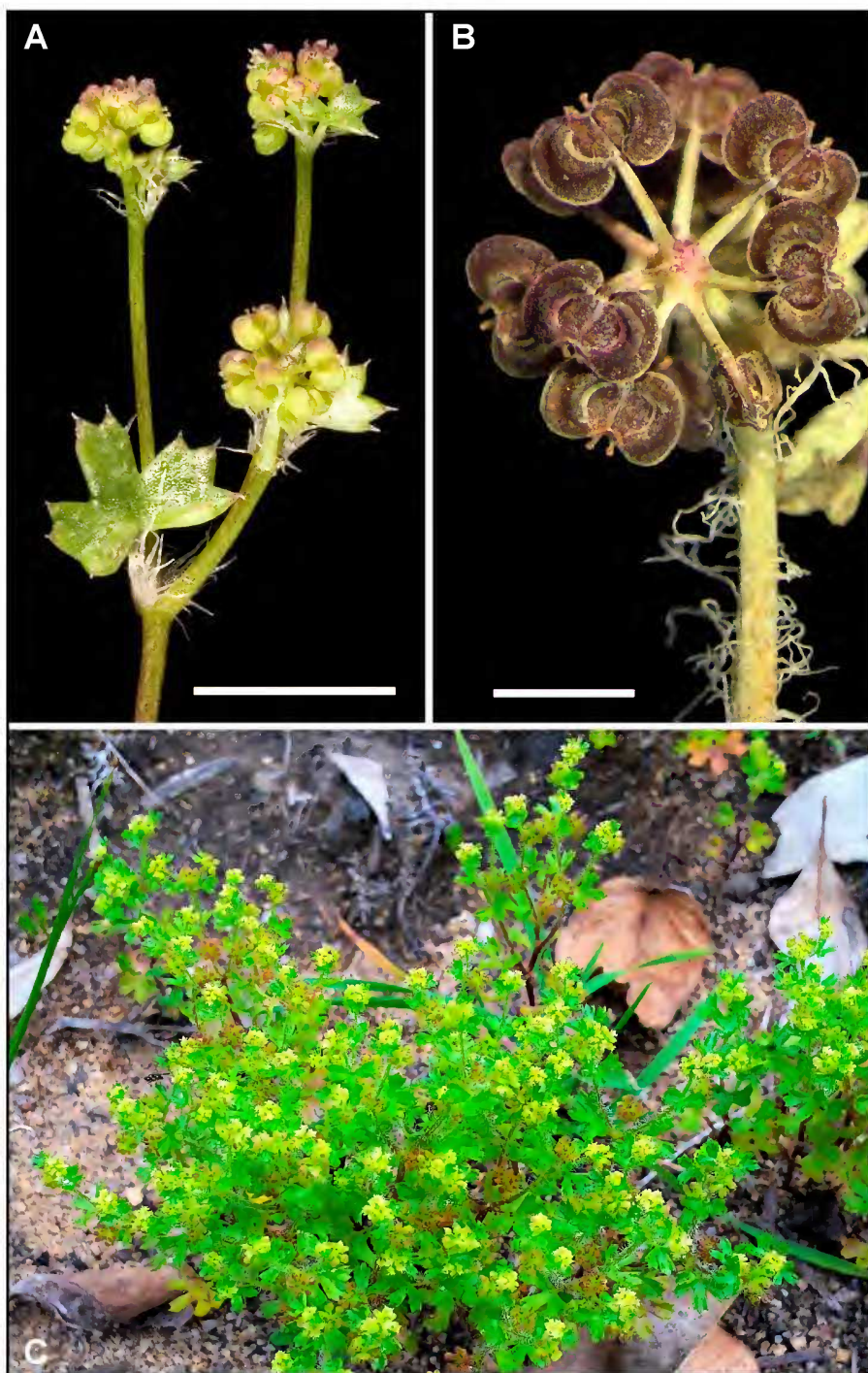


Figure 1. *Hydrocotyle callicarpa*. A – portion of flowering plant showing leaves with hairs on the laminae and tips of marginal teeth, stipules with distinctly ciliate margins, and orbicular umbellate inflorescences; B – infructescence with mature schizocarps; C – fertile plants growing *in situ*. Scale bars = 10 mm (A); 2 mm (B). Vouchers: K. Thiele KRT 3374 (PERTH 07893043) (A); A.J. Perkins & R. Davis AJP-WA 108 (PERTH 08726493) (B, C). Photographs by K. Thiele (A); A. Perkins (B, C).

toothed; teeth obtuse to acute. *Median leaflobes* ovate to oblanceolate, 2.0–4.0 mm long, 1.5–2.5 mm wide, with 1–3 teeth. *Lateral leaflobes* 2.0–4.5 mm long, 1.5–2.5 mm wide, with 1–3 marginal teeth, incised into 2 asymmetrical lobules in palmatifid leaves; leaf sinuses 20–60% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, orbicular, anthesis centripetal, 6–14-flowered, 2.0–3.5 mm wide. *Peduncles* terete to subterete, shorter than subtending leaf at anthesis, becoming equal to or slightly longer than subtending leaf when in fruit, 0.5–4.0 mm long, glabrous. *Involucral bracts* absent. *Pedicels* yellowish green to pale crimson, subterete, longitudinally flattened, 0.1–0.4 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.3–0.6 mm long, 0.3–0.5 mm wide. *Filaments* pale cream, 0.3 mm long. *Anthers* creamy yellow, orbicular to elliptic, 0.1–0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.4–0.8 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest at the middle (in lateral view), cordate at the base; commissure 95% the length of mericarps. *Mericarps* pale green turning to crimson to dark reddish brown at maturity, 0.6–0.8 mm long, 0.7–0.8 mm wide, smooth to minutely verrucate; dorsal rib prominent, keeled; lateral ribs conspicuously raised, incurved towards median ribs; mericarp surface between dorsal and lateral ribs flattened, glabrous; surface between lateral and median ribs deeply concave, margin of pit with a thickened reddish orange or reddish brown rim, centre of concave pit with 2 (rarely 3) papillae. *Carpophores* persistent, subulate, 0.5 mm long. *Fruiting styles* slightly swollen at the base, 0.3 mm long, erect to partially reflexed. *Cotyledons* oblong to oblanceolate in the seedlings. (Figure 2)

Diagnostic features. *Hydrocotyle eichleri* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending to erect annual herbs up to 5 cm high with relatively thick (and glabrous) stems, petioles, peduncles and pedicels; stipules with few teeth or entire margins; schizocarps cordate at the base, with thickened lateral ribs that are raised and incurved towards the median ribs; mericarps glabrous between dorsal and lateral ribs and with a deep concave pit between lateral and median ribs, the pit with a rimmed margin and 2(3) papillae at the centre (see Figure 2C); carpophores persistent and subulate.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 6 Oct. 1994, R.J. Bayer WA 94083 (ALTA, PERTH); 3 Oct. 1985, H.J. Eichler 23772 (CANB); 9 Oct. 1998, M.N. Lyons & S.D. Lyons 3887 (PERTH); 1890, E. Merall s.n. (MEL 0008336); 22 Sep. 1980, K.R. Newbey 7567 (PERTH); 7 Oct. 1981, K.R. Newbey 9245 (CANB, PERTH); 4 Sep. 1967, P.G. Wilson 6185 (AD, PERTH); 29 Sep. 1970, P.G. Wilson 9985 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to October.

Distribution and habitat. *Hydrocotyle eichleri* is currently known from nine general localities, scattered north–south for approximately 400 km, from Lake Deborah area in the north, to the Esperance region in the south and east–west for approximately 400 km, from Dundas Nature Reserve in the east, to the Bruce Rock area in the west (Figure 3). This species grows in sandy loam soils surrounding the margins of inland salt lakes and saline pans (Figure 2D).

Conservation status. *Hydrocotyle eichleri* is listed as Priority Three under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Crassipes (K.R. Newbey 7567) (Smith & Jones 2018).

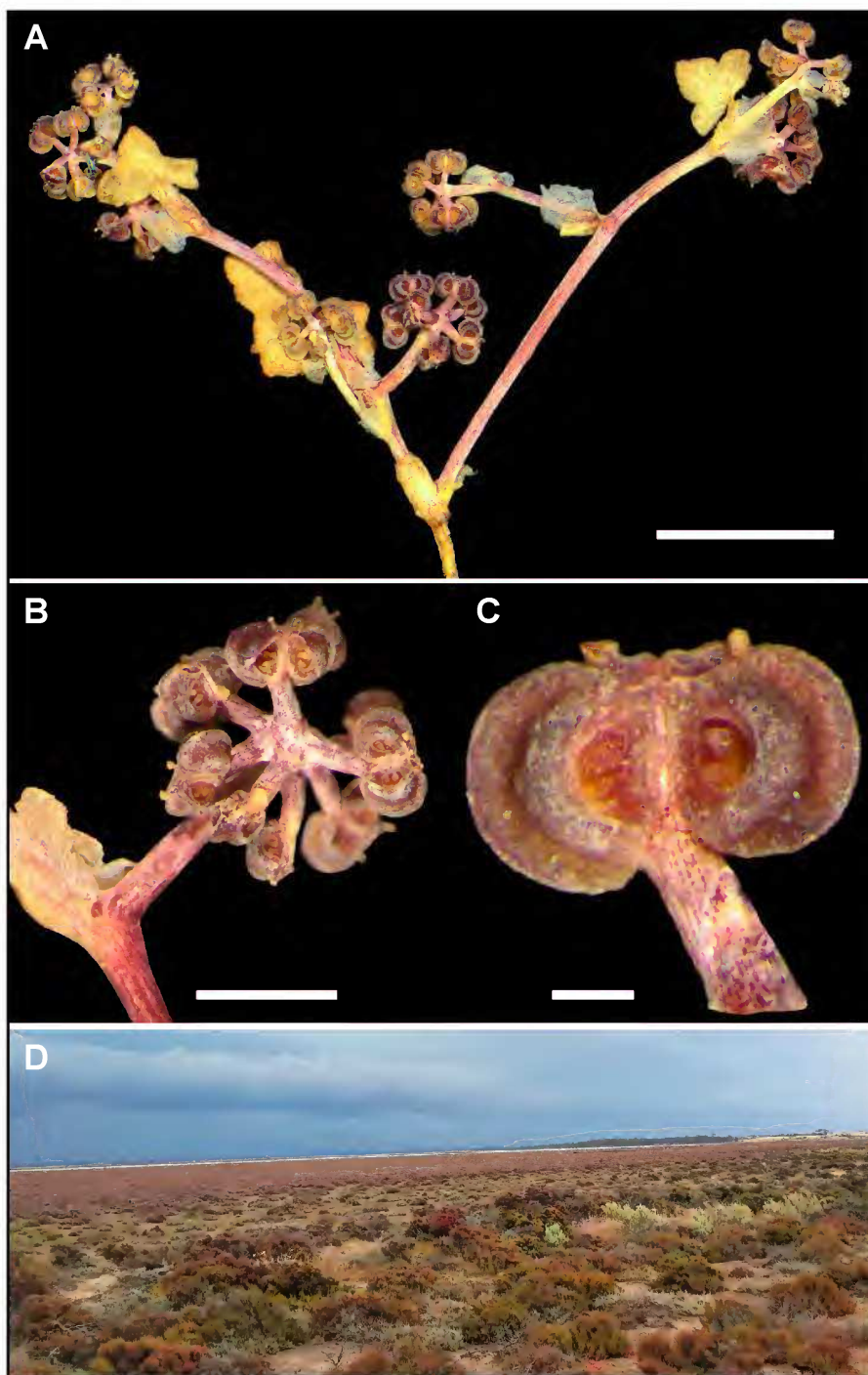


Figure 2. *Hydrocotyle eichleri*. A – herbarium voucher showing flowers and developing fruits borne in simple umbels; B – infructescence showing the relatively thick stem, peduncle and pedicels; C – lateral view of a mature schizocarp showing prominently raised and thickened lateral ribs that are incurved, surrounding 2 concave pits, each containing 2 papillae; D – typical habitat. Scale bars = 5 mm (A); 1 mm (B); 0.1 mm (C). Voucher: M.N. Lyons & S.D. Lyons 4890 (A–C). Photographs by A. Perkins.

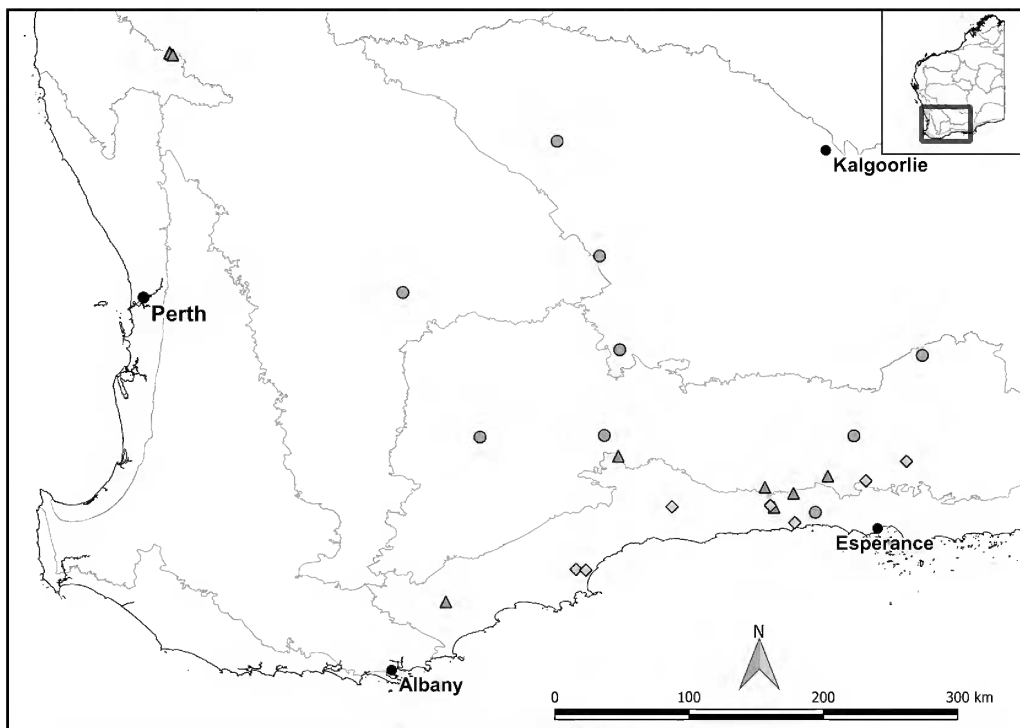


Figure 3. Distribution of *Hydrocotyle eichleri* (●), *H. papilionella* (▲) and *H. tuberculata* (◆) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2017).

Etymology. The specific epithet honours the late Hansjörg Eichler (1916–1992) in recognition of his significant contribution to the taxonomy of *Hydrocotyle* (Eichler 1965, 1987a, 1987b, 1987c). The common name, ‘Eichler’s Pennywort’ is here suggested.

Affinities. *Hydrocotyle eichleri* is morphologically similar to the widespread winter annual *H. callicarpa* and the two rare Western Australian annuals *H. papilionella* A.J.Perkins and *H. tuberculata* A.J.Perkins. All four species possess ebracteate umbellate inflorescences, fruits with conspicuously raised and incurved lateral ribs, distinctly concave ‘pits’ between the lateral and median ribs, and persistent subulate carpophores.

Hydrocotyle eichleri can readily be distinguished from *H. callicarpa* by having entire to shallowly toothed stipules (distinctly fimbriate in *H. callicarpa*), glabrous leaf laminas (sparsely hairy in *H. callicarpa*), glabrous marginal teeth on the leaf blades (marginal teeth tipped with setose hairs in *H. callicarpa*), relatively thick pedicels (slender pedicels in *H. callicarpa*), the mericarp surface between the lateral and median ribs containing a conspicuous concave pit with a rimmed margin and two papillae in the centre of each pit (glabrous and lacking rimmed pits in *H. callicarpa*) (See Figures 1B, 2A, B). Both *H. papilionella* and *H. tuberculata* share the characters of having glabrous stems, leaves and peduncles, as well as papillate mericarp surfaces with *H. eichleri*. They both differ from *H. eichleri* in that they have papillate mericarp surfaces between the dorsal and lateral ribs (glabrous in *H. eichleri*) and the fruit lack rimmed pits (Figures 2C, 4B, 5B).

Hydrocotyle papilionella A.J.Perkins, *sp. nov.*

Type: south-east of Coorow, Western Australia [precise locality withheld for conservation reasons], 26 September 1999, *M.N. Lyons & S.D. Lyons* 4891 (*holo:* PERTH 08933510; *iso:* MEL).

Hydrocotyle vigintimilia H.Eichler ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Hydrocotyle sp. *Vigintimilia* (P.G. Wilson 7940), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Annual herbs consisting of 2–5 basal leaves and branched stems bearing leaves and umbellate inflorescences, 1.5–6.0 cm high and 1–7 cm wide. *Stems* erect to ascending, pale green to reddish green, terete, glabrous. *Stipules* cream to light creamy brown, elliptic to broadly ovate, 0.8–2.0 mm long, 0.5–1.5 mm wide, membranous, translucent, irregularly toothed to occasionally entire along margins. *Petioles* pale green to reddish green, 0.4–5.0 mm long, glabrous. *Leaf blades* simple, dorsiventral, carnos, rhombic to shallowly trilobed in juvenile leaves, trilobed to occasionally palmatifid in mature leaves, 1.2–2.6 mm long, 1.2–4.5 mm wide; adaxial surface light green, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous. *Leaf margins* toothed; teeth mostly rounded to obtuse or occasionally acute. *Median leaflobes* ovate to oblanceolate, 1.2–2.6 mm long, 0.8–1.7 mm wide, with 1 marginal tooth. *Lateral leaflobes* 1.5–2.3 mm long, 0.7–1.8 mm wide, with 1–3 marginal teeth; leaf sinuses 20–50% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 3–8-flowered, 2–3 mm wide. *Peduncles* terete, much shorter than opposing leaf at anthesis, becoming as long or longer than subtending leaf when in fruit, 0.2–4.5 mm long, glabrous. *Involucral bracts* absent. *Pedicels* light green, subterete, longitudinally flattened, 0.1–0.3 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface towards the apex, ovate, 0.4–0.6 mm long, 0.3–0.4 mm wide. *Filaments* pale cream, 0.3–0.4 mm long. *Anthers* creamy yellow or occasionally crimson, elliptic, 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, broadly obcordate, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.2–0.8 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest towards the summit (in lateral view) such that they appear butterfly-shaped, truncate at the base; commissure 95% the length of mericarps. *Mericarps* light green turning dark brown at maturity, 0.7–0.8 mm long, 0.6–0.7 mm wide, minutely verrucate to colliculate; dorsal rib conspicuous, winged at maturity; wing above the midpoint of the dorsal rib and protruding 0.1–0.2 mm from it, pale brown, shallowly triangular, obtuse to acute or occasionally notched; lateral ribs prominently thickened and raised, slightly incurved towards median ribs; surface between dorsal and lateral ribs flattened, with a longitudinal row of 4–8 papillae adjacent to the raised lateral rib; surface between lateral and median ribs deeply concave, with a row of 3–5 papillae adjacent to lateral rib. *Carpophores* persistent, subulate, 0.5–0.6 mm long. *Fruiting styles* slender at the base, 0.2 mm long, porrect. *Cotyledons* elliptic to oblanceolate in the seedlings. (Figure 4)

Diagnostic features. *Hydrocotyle papilionella* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending to erect annual herbs up to 6 cm high with glabrous stems, petioles, leaves and peduncles; stipules with few teeth or entire along margins; subsessile to shortly pedunculate umbels bearing 3–8 flowers; schizocarps truncate at the base, with a slender angular wing along the dorsal ribs, raised lateral ribs that are incurved towards the median ribs; mericarps flattened between dorsal and lateral ribs, with a longitudinal row of 4–8 papillae adjacent to the raised lateral rib, and deeply concave between lateral and median ribs, with a row of 3–5 papillae adjacent to lateral rib (see Figure 4B); carpophores persistent and subulate.

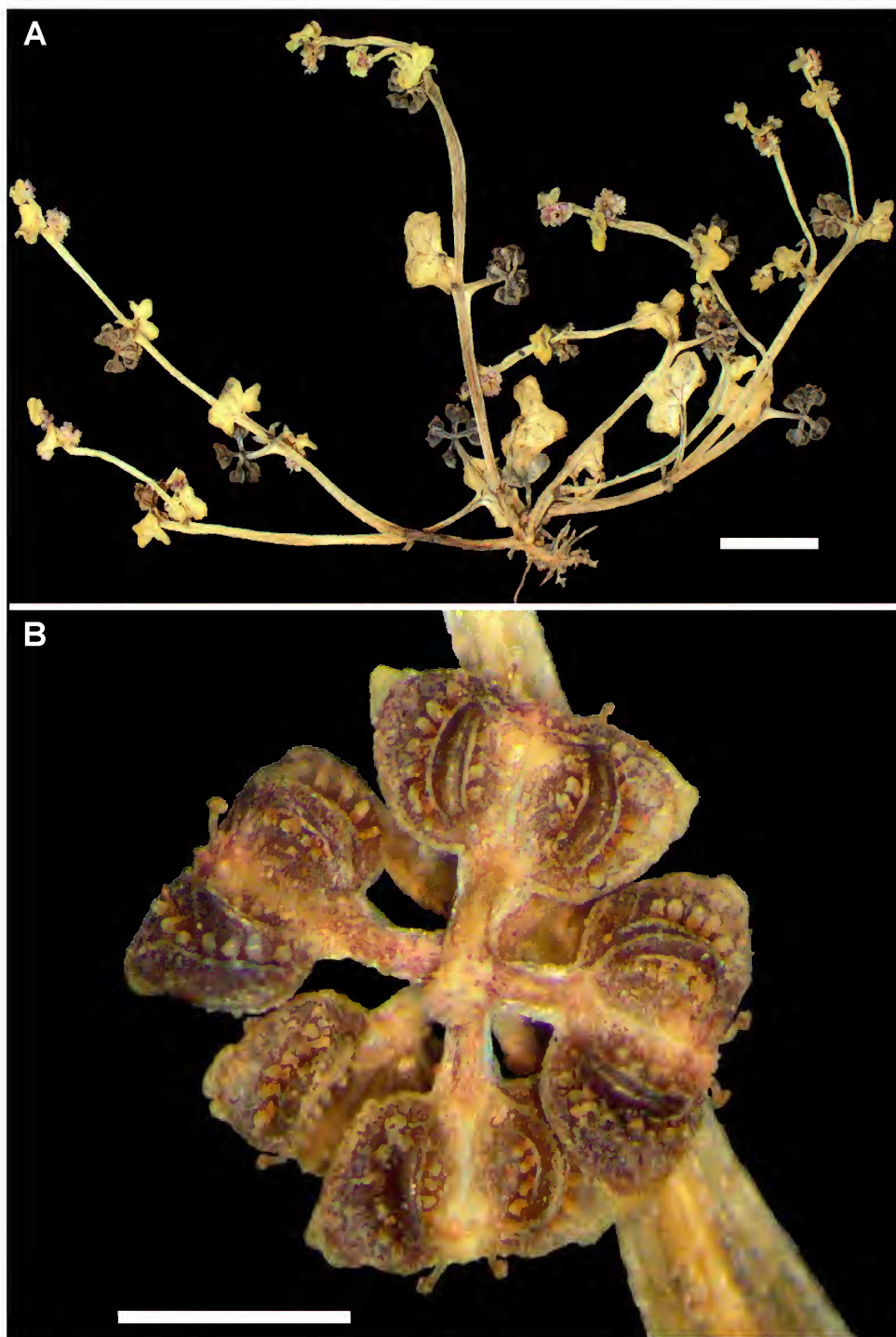


Figure 4. *Hydrocotyle papilionella*. A – herbarium voucher showing flowers and developing fruits borne on simple umbels; B – mature infructescence showing winged schizocarps with distinctive longitudinal rows of papillae either side of the raised lateral ribs. Scale bars = 5 mm (A); 1 mm (B). Voucher: M.N. Lyons & S.D. Lyons 4891 (A, B). Photographs by A. Perkins.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Oct. 1968, *N.N. Donner* 3029 (CANB); 27 Sep. 1968, *Hj. Eichler* 20000 (CANB); 10 Sep. 1971, *Hj. Eichler* 21160 (CANB); 11 Sep. 1985, *Hj. Eichler* 23675 (CANB, PERTH); 22 Sep. 1998, *E.M. Sandiford* 247 (PERTH); 1 Nov. 2016, *E.M. Sandiford & S. Barrett* 2316 (PERTH); 24 Oct. 1983, *P.S. Short* 2204 (MEL); 26 Sep. 1968, *P.G. Wilson* 7940 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle papilionella* is currently known from seven general localities with a large north–south disjunction in populations of around 540 km (Coorow to Mt Madden). The six southern populations are spread over 310 km, from Scaddan south-west to the Stirling Range (Figure 3). This species grows in damp loam soils surrounding the margins of inland salt lakes and in damp granitic sandy loams surrounding exposed granite outcropping.

Conservation status. *Hydrocotyle papilionella* is listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *H. sp. Vigintimilia* (P.G. Wilson 7940).

Etymology. The epithet is derived from the Latin ‘*papilio*’ (genitive *papilionis*) and means ‘a small butterfly’, which is a reference to the lateral profile of the fruit (Figure 4B). The common name, ‘Butterfly Pennywort’ is here suggested.

Affinities. *Hydrocotyle papilionella* can be readily distinguished from *H. callicarpa*, *H. eichleri* and *H. tuberculata* by having schizocarps that are broadest towards the summit (compared to broadest at the centre) with projecting angular wings and truncate bases, thus giving the fruit their distinctive butterfly-shaped appearance (Figure 4). Additionally, the papillae on each mericarp in *H. papilionella*, are characteristically arranged in two longitudinal rows, each (row) separated by the raised lateral rib (see Figure 4B). *Hydrocotyle papilionella* can be further distinguished from *H. callicarpa* by having entire to shallowly toothed stipules (distinctly fimbriate in *H. callicarpa*), glabrous leaf laminae (sparsely hairy in *H. callicarpa*) and glabrous marginal teeth on the leaf blades (marginal teeth tipped with setose hairs in *H. callicarpa*) (See Figures 1, 4).

Hydrocotyle tuberculata* A.J.Perkins, *sp. nov.

Type: south-east of Scaddan, Western Australia [precise locality withheld for conservation reasons], 20 October 2017, *A.J. Perkins* AJP-WA 139 (*holo:* PERTH 08935041; *iso:* AD, CANB, MEL).

Hydrocotyle decipiens H.Eichler ms, Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Hydrocotyle sp. Decipiens (G.J. Keighery 463), Western Australian Herbarium, in *FloraBase*, <https://florabase.dpaw.wa.gov.au/> [accessed 26 January 2018].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 2–10 cm high and 1–18 cm wide. *Stems* ascending, reddish green to crimson, terete, glabrous. *Stipules* white, lanceolate to broadly ovate, 0.7–2.5 mm long, 0.5–1.4 mm wide, membranous, translucent, incised to lacinate along margins. *Petioles* reddish green to crimson, 1.5–25.0 mm long, glabrous or rarely subglabrous. *Leaf blades* simple, dorsiventral, carnosely, trilobed to palmatifid,

1.5–9.0 mm long, 2.0–12.5 mm wide; adaxial surface green to reddish green, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous or rarely subglabrous. Leaf margins toothed; teeth mostly rounded to obtuse, rarely acute. *Median leaf lobes* ovate to oblanceolate, 1.5–5.0 mm long, 1.0–3.5 mm wide, with 1–3 teeth. *Lateral leaf lobes* 1.1–4.5 mm long, 0.8–4.5 mm wide, with 1–6 marginal teeth, incised into 2 asymmetrical lobules in palmatifid leaves; leaf sinuses 20–80% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 3–22-flowered, 1.5–3.0 mm wide. *Peduncles* terete, shorter than subtending leaf at anthesis, becoming predominantly longer than subtending leaf or occasionally remaining subsessile when in fruit, 0.4–20.0 mm long, glabrous. *Involucral bracts* absent. *Pedicels* green to reddish green, subterete, longitudinally flattened, 0.2–0.4 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.5–0.6 mm long, 0.2–0.3 mm wide. *Filaments* pale cream, 0.3 mm long. *Anthers* creamy yellow, elliptic, 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.5–1.6 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest at the middle (in lateral view), cordate at the base; commissure 95% the length of mericarps. *Mericarps* green turning crimson to dark reddish brown at maturity, 0.6–0.7 mm long, 0.5–0.6 mm wide, tuberculate; dorsal rib prominent, keeled; lateral ribs conspicuously raised, slightly incurved towards median ribs; surface between dorsal and lateral ribs flattened, covered with papillae; surface between lateral and median ribs concave, densely covered with papillae. *Carpophores* persistent, subulate, 0.3–0.6 mm long. *Fruiting styles* slender at the base, 0.2–0.3 mm long, erect to fully reflexed. *Cotyledons* elliptic to ovate in the seedlings. (Figure 5)

Diagnostic features. *Hydrocotyle tuberculata* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending annual herbs up to 10 cm high, often with reddish green to crimson stems, leaves, peduncles and pedicels; stipules with few teeth or entire along margins; simple umbels bearing 3–22 flowers; schizocarps cordate at the base, with raised lateral ribs that are incurved towards the median ribs; mericarps tuberculate between dorsal and lateral ribs, distinctly concave and tuberculate between lateral and median ribs (see Figure 5B); carpophores persistent and subulate.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Oct. 2005, *G.F. Craig* 6943 (PERTH); 31 Oct. 2005, *G.F. Craig* 6948 (PERTH); 10 Oct. 1968, *Hj. Eichler* 20169 (CANB); 1 Nov. 1975, *G.J. Keighery* 463 (PERTH); 7 Sep. 1971, *E.F. Melville & R. Melville* 71.195 (NSW); 13 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08012806, SYD); 6 Oct. 1970, *P.G. Wilson s.n.* (PERTH 03539830).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle tuberculata* is currently known from seven general localities spread east–west over 250 km from the Mt Ridley area to Fitzgerald River National Park (Figure 3). This species grows in damp sandy loam soils associated with winter-moist creeklines and drainage areas associated with inland saline lakes (Figure 5C).

Conservation status. *Hydrocotyle tuberculata* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. *Decipiens* (G.J. Keighery 463).

Etymology. The epithet *tuberculata* is derived from the Latin ‘*tuberculatus*’, with tubercles or bumps,

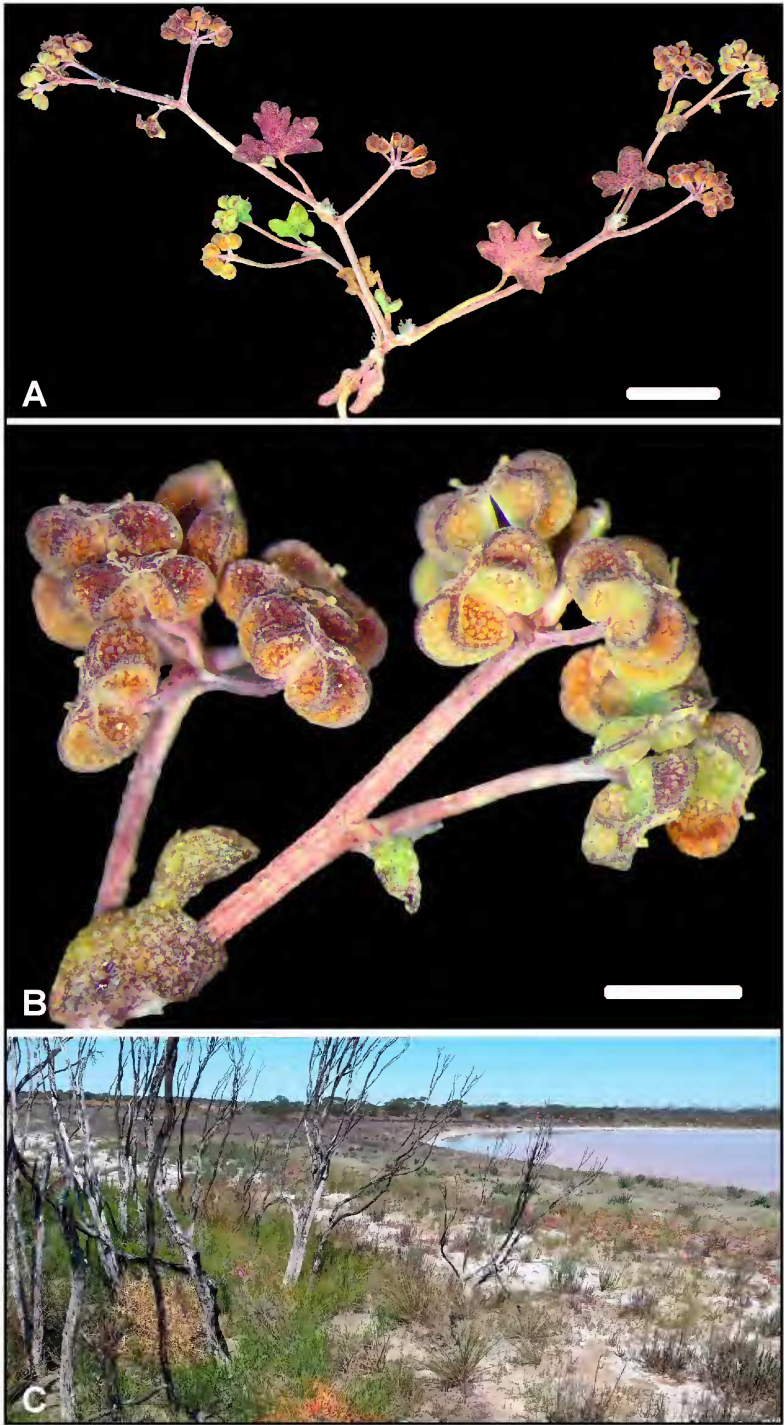


Figure 5. *Hydrocotyle tuberculata*. A – herbarium voucher showing flowers and developing fruits borne on simple umbels; B – maturing infructescences showing tuberculate schizocarps with the distinctive raised and incurved lateral ribs; C – typical habitat adjacent to an inland salt lake. Scale bars = 5 mm (A); 1 mm (B). Voucher: *A.J. Perkins* AJP-WA 139 (A, B). Photographs by A. Perkins.

in reference to the numerous tubercles (papillae) on the mericarp surfaces (Figures 5B). The common name, ‘Bumpy-fruited Pennywort’ is here suggested.

Affinities. *Hydrocotyle tuberculata* can be readily distinguished from *H. callicarpa*, *H. eichleri* and *H. papilionella* by having many papillae on mericarp surfaces between the dorsal, lateral and median ribs (Figure 5B). In the field, mature plants are reddish green to dark crimson in colour, including the ripening fruit. *Hydrocotyle tuberculata* differs from *H. papilionella* by its wingless schizocarps (Figure 4B) and differs from *H. eichleri* by the lack of a rim surrounding the concave ‘pits’ between the lateral and median ribs (Figure 2C). Additionally, *H. tuberculata* differs from *H. callicarpa* by having stipules with incised to lacinate margins (stipules prominently fimbriate in *H. callicarpa*), glabrous leaf laminae (sparsely hairy in *H. callicarpa*) and glabrous marginal teeth on the leaf blades (teeth tipped with setose hairs in *H. callicarpa*) (Figures 1, 5).

Acknowledgements

The author thanks Julia Percy-Bower and Karina Knight (Western Australian Herbarium) for curatorial assistance, Kevin Thiele (University of Western Australia) for permission to use his photograph, Mike Lyons (Department of Biodiversity, Conservation and Attractions) for providing additional vouchers from the Salinity Action Plan Flora Survey to the Western Australian Herbarium and for sharing his valuable field knowledge. Andrew Orme (National Herbarium of New South Wales) and Aaron McArdle (National Herbarium of Victoria) are thanked for their assistance with voucher images, Carolyn Connelly (National Herbarium of New South Wales) and Karen Muscat are thanked for assistance in the field. The curators of CANB (Australian National Herbarium) and MEL (National Herbarium of Victoria) are thanked for providing access to their holdings. Thanks also to Murray Henwood for access to additional CANB vouchers on loan to SYD (John Ray Herbarium) and the late Hansjörg Eichler for his significant contribution to the systematics of *Hydrocotyle*.

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